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EXPLORING THE ROLE OF BIOMASS GASIFICATION IN RURAL ELECTRIFICATION

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Characteristics of Rural Electrification

- sites are situated far away from regular large scale power grids
- (expected) electricity consumption necessitates installation of small power capacities
- (expected) electricity consumption patterns necessitates the operation of installed power capacities at (very) low capacity factors



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Some Technical Options in Rural Electrification

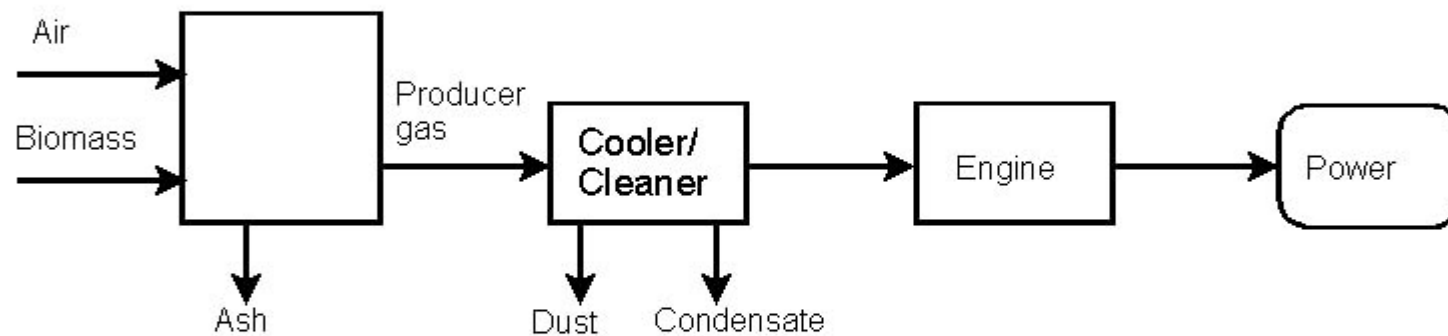
1. Connect individual households to a small isolated grid powered by a small generator
2. Provide individual households with batteries charged at a small central station powered by a small generator
3. Provide individual households with individual solar home systems, i.e. provide each household with its own battery charging system

N.B. Options 2. and 3. do not provide the same service as option 1.

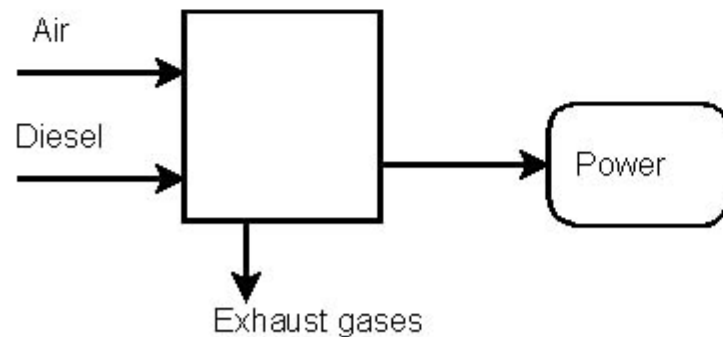


The Power Systems Considered

A. Gasifier System for Power Generation



B. Diesel system for Power Generation



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Qualitative Comparison of Options

	Gasifier	Diesel Engine	
General			
- Commercial Status	demo	fully commercial	
- Personnel	clear skill (w/r) some skill (c)	little skill	
- Pollution	(some) problems (w/r) little problems (c)	little problems	
- Health & Safety	some problems	little problems	
Technical			
- Efficiency	low-medium	medium-high	
- Reliability	low/medium (w/r) medium (c)	(very) high	
Financial			
- Capital Cost	high (w/r) medium (c)	low	
- Fuel Cost	low (w/r) medium (c)	high	
- Personnel Cost	high (w/r) medium (c)	low	
- Maintenance Cost	high (w/r)	low	(w/r): wood /residue (c): charcoal

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Capacity Factors (CF), Operating Hours (OH) and Full-load Equivalent Hours (FLH) in Rural Electrification (Typical Values)

	CF (%)	OH (hrs/yr)	FLH (hrs/yr)
Households only	10.5	1 965	982.5
Households & Commercial/Industrial Services	35	6 065	3 032.5
Households & Battery Charging Service	55	6 065	4 852

	Households Only	Household & Services	Households & Battery Charging
Operational Period (OP) (wk/yr)	52	52	52
(d/wk)	7	6	6
(hr/d)	6	24	24
Planned Maintenance during Operational Period (% OP)	0	10	10
Availability Factor (%)	90	90	90
Load Factor (%)	50	50	50

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Specific Capital Costs of Power Systems (US\$/kW_{el})

	Fuel	Charcoal	Wood/residues	Diesel
Capacity				
10 kW _{el}		1085-1870*		720*
		1250**		
30 kW _{el}			784-1594*	470*
40 kW _{el}		620**	1120**	300**
100 kW _{el}			504-1225*	290*
160 kW _{el}			920**	160*

* according to Stassen

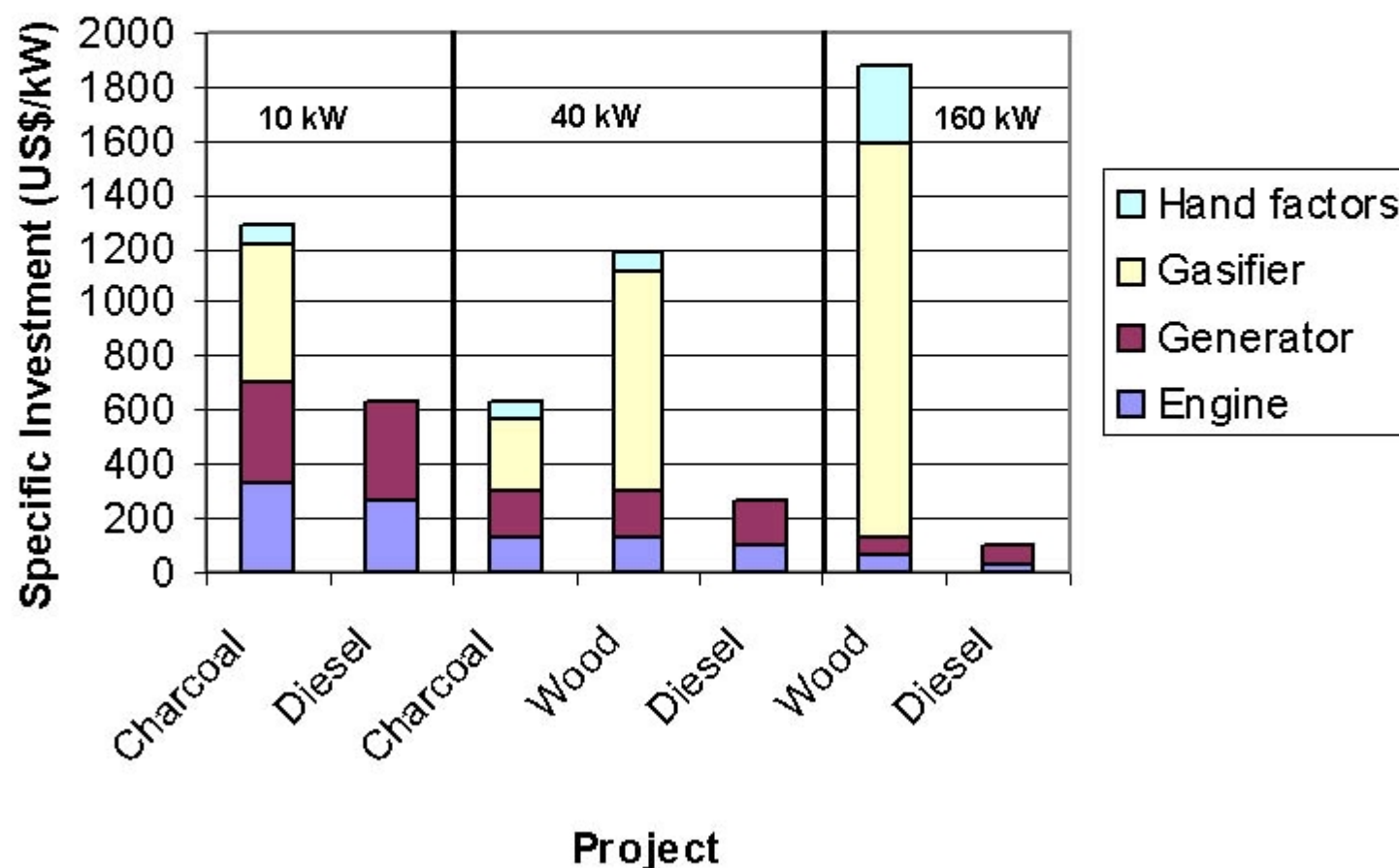
** according to Siemons

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Capital cost breakdown of different Power Systems



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Typical Fuel Prices in Selected Developing Countries

Country	Charcoal ^a		Wood ^a		Diesel	
	US\$/t	US\$/GJ	US\$/t	US\$/GJ	US\$/t	US\$/GJ
Ghana						
Production Zone	54.0	1.90	13.5	0.95	0.3	4.83
Accra	108.0	3.79	27.0	1.89	0.30	4.83
Indonesia	83.7	2.97	14.4	1.01	0.039	0.62
Mali	76.5	2.69	24.3	1.67	0.110	3.04
Vanuatu - Tanna	131.4	4.61	33.3	2.52	0.57	9.18

Diesel fuel ex refinery					0.17	3.07
(Rotterdam) ^b						

a/ Estimated by the author, based on Ahiataku-Togobo (1998), Meuleman (1999) and Sanogo (2000).

b/ At crude oil price of 18 US\$/barrel, Calculated according to Berg, Boot et al. (1997).



CONCLUSIONS

1. The feasibility of gasification power systems in village operations is very sensitive to the capacity factor of such systems. Low capacity factors render gasification power systems unfeasible. This sensitivity is specifically pronounced at capacity factors in the range between 10 and 50 %. Unfortunately typical village power systems show low capacity factors in the range of 10 to 35 %.
 2. Although charcoal is more expensive than wood (on an energy basis) it can out compete wood as a fuel for gasification at capacities up to around 40 kW_{el}. The most important reasons are:
 - a. the lower specific investment cost of charcoal gasifiers;
 - b. higher reliability of charcoal gasifiers; and
 - c. lower operation & maintenance costs of charcoal gasification systems.
 3. Prevailing fuel prices and investment levels suggest that for small scale charcoal gasification projects (10-40 kW_{el}), conditions for financially feasible projects are easier to satisfy than for slightly larger wood gasification projects (40-160 kW_{el}).
 4. It cannot be excluded that there do exist sites where wood and specifically residue fuelled gasification systems can be operated in a financially viable way. However those sites represent a small niche and are difficult to locate.
 5. A large market for biomass gasification can be addressed if:
 - a. a drastic cost reduction is achieved by the manufacturing industry; and
 - b. the reliability of (specifically) wood gasification systems can be increased
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